Manual of Sensor less Brushless Motor Speed Controller Ver. HW-01-081027.1

Thanks for purchasing our Electronic Speed Controller (ESC). High power system for RC model can be very dangerous, so we strongly suggest you read this manual carefully and thoroughly. In that we have no control over the correct use, installation, application, or maintenance of this product, no liability shall be assumed nor accepted for any damages, losses or costs resulting from the use of the product. Any claims arising from the operating, failure or malfunctioning etc. will be denied. We assume no liability for personal injury, property damage or consequential damages resulting from our product or our workmanship. As far as is legally permitted, the obligation to compensation is limited to the invoice amount of the affected product.

Features:

- **Balance Discharge Monitoring and Protection (BDMP) Design for lithium battery pack.** This innovative new system provides real time monitoring of the discharge voltage of each cell in your lithium (Li-ion/Li-poly) battery packs. Since each cell is monitored and protected by the ESC, you can expect an even longer service life from your battery packs as you fly with increased confidence. **(Remark: This function is ONLY available for the "Guard" series ESC)**
- Compatible with Lithium and Nickel battery types. (Lithium-Ion / Lithium-Polymer or Nickel Metal Hydride / Nickel Cadmium)
- Extreme low output resistance, super current endurance.
- Multiple protection features: Low-voltage cut-off protection / over-heat protection / throttle signal loss protection.
- 3 start modes: Normal / Soft / Super-Soft, compatible with fixed-wing aircraft and helicopter.
- Throttle range can be configured to be compatible with all transmitters currently available on market.
- Smooth, linear and precise throttle response.
- Separate voltage regulator IC for microprocessor (except Pentium-6A and Pentium-10A), providing good anti-jamming capability.
- Supported motor speed (Maximum): 210000 RPM (2 poles), 70000 RPM (6 poles), 35000 RPM (12 poles).
- Our pocket-sized **Program Card** can be purchased separately for extremely easily programming the ESC at the field.
- With a program card, you can activate the music playing function of the ESC, and totally there are 15 songs can be selected.

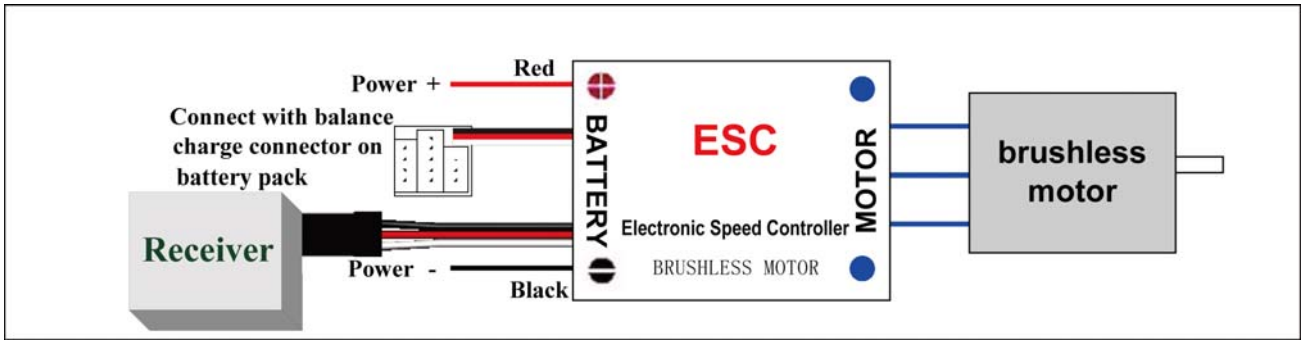
Specifications:

Pentium Series											
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode (*Note1*)	BEC Output	Battery Cell		User Programm-able	Balance Discharge Protection	Weight	Size
						Li-ion Li-poly	NiMH NiCd				L*W*H
22A	GUEC-GE-221	22A	25A	Linear	5V/2A	2-4	5-12	Available	N/A	19g	45*24*11
66A	GUEC GE-602	66A	80A	Switch	5V/3A	2-6	5-18	Available	N/A	60g	70*31*14

BEC Output Capability	Linear Mode BEC(5V/2A)				Switch Mode BEC(5V/3A)	
	2S Li-Poly	3S Li-Poly	4S Li-Poly	5S Li-Poly	2S - 4S Li-Poly	5S-6S Li-Poly
Standard micro servos(Max.)	5	4	3	2	5	4

IMPORTANT! The ESC named "xxx-xxx-OPTO" does not have a built-in BEC. An UBEC (Ultimate-BEC) or an individual battery pack should be used to power the receiver. And an individual battery pack is needed to power the program card when setting the programmable value of such ESCs. Please read the user manual of program card for reference.

Wiring Diagram:



Programmable Items:

1. **Brake Setting**：Enabled / Disabled, default is Disabled
2. **Battery Type**：Li-xx(Li-ion or Li-poly) / Ni-xx(NiMH or NiCd)，default is Li-xx.
3. **Low Voltage Protection Mode(Cut-Off Mode)**： Soft Cut-Off (Gradually reduce the output power) or Cut-Off (Immediately stop the output power). Default is Soft Cut-Off.
4. **Low Voltage Protection Threshold(Cut-Off Threshold)**：Low / Medium / High, default is Medium.
   - **When NOT using balance discharge monitoring and protection function** (i.e. **Not** plugging the balance charge connector into the BDMP socket on the Guard series ESC, the ESC only monitors the voltage of the whole battery pack)
     1) For lithium batteries, the number of battery cells is calculated automatically. Low / medium / high cutoff voltage for each cell is: 2.6V/2.85V/3.1V. For example: For a 3 cells lithium pack, when “Medium” cutoff threshold is set, the cut-off voltage will be: 2.85*3=8.55V.
     2) For nickel batteries, low / medium / high cutoff voltages are 0%/45%/60% of the startup voltage (i.e. the initial voltage of battery pack), and 0% means the low voltage cut-off function is disabled. For example: For a 10 cells NiMH battery, fully charged voltage is 1.44*10=14.4V, when “Medium” cut-off threshold is set, the cut-off voltage will be:14.4*45%=6.5V。
   - **When using balance discharge monitoring and protection function** (i.e. Plugging the balance charge connector on battery pack into the BDMP socket on the Guard series ESC, the ESC monitors not only the voltage of the whole battery pack but also the voltage of each cell). For lithium battery，low / medium / high cut off voltage for each cell is: 2.6V/2.85V/3.1V. When the voltage of any cell in battery pack is lower than the cut-off threshold, the protection function is activated.
5. **Startup Mode**：Normal /Soft /Super-Soft, default is Normal.
   Normal is preferred for fixed-wing aircraft. Soft or Super-soft are preferred for helicopters. The initial acceleration of the Soft and Super-Soft modes are slower in comparison, usually taking 1 second for Soft startup or 2 seconds for Super-Soft startup from initial throttle advance to full throttle. If the throttle is closed (throttle stick moved to bottom) and opened again (throttle stick moved to top) within 3 seconds of the initial startup, the restart-up will be temporarily changed to normal mode to get rid of the chances of a crash caused by slow throttle response. This special design is very suitable for aerobatic flight when quick throttle response is needed.
6. **Timing**：Low / Medium / High, default is Low. *Note2*
   Usually, low timing value can be used for most motors. We recommend the **Low** timing value for 2 poles motor and **medium** timing value for motors with more than 6 poles to get a high efficiency. For higher speed, **High** timing value can be chosen.
   ***Note2*: After changing the timing setting, please test your RC model on the ground prior to flight!**

Special Note

Some high KV out-runner motors have very special construction, the space between each magnet is very large, and many ESCs can’t drive these motors. After much testing, our ESCs have proven to work very well with these types of motors. Some RC enthusiasts still have several questions about the programming value for these special motors. Therefore, we have provided some suggestions as follows:

Programmable Value Suggestion / Motor	Timing	Startup Mode
Generic in-runner motor	Low	Usually, aircraft use “Normal” startup mode and helicopter use “Super-soft” startup mode
Generic out-runner motor	Low or Medium	
Align 420LF (Made in TAIWAN, out-runner)	High (MUST)	
450TH (Made in TAIWAN, out-runner)	Low	Soft (MUST)

Begin To Use Your New ESC

Please start the ESC in the following sequences:

1. Move the throttle stick to the bottom position and then switch on the transmitter.
2. Connect the battery pack to the ESC, the ESC begins the self-test process, a special tone “ ♪ 123” is emitted, which means the voltage of the battery pack is in normal range, and then N “beep” tones will be emitted, means the number of lithium battery cells. Finally a long “beep------” tone will be emitted, which means self-test is OK, the aircraft/helicopter is ready to go flying.
   - If nothing is happened, please check the battery pack and all the connections;
   - If a special tone “ ♪ 56712” is emitted after 2 beep tones (“beep-beep-”), means the ESC has entered the program mode, it is because the throttle channel of your transmitter is reversed, please set it correctly;
   - If the very rapid “beep-beep-, beep-beep-” tones is emitted, means the input voltage is too low or too high, please check your battery’s voltage.

VERY IMPORTANT!

Because different transmitter has different throttle range, we strongly suggest you use the “Throttle Range Setting Function” to calibrate throttle range. Please read the instruction on page 4------“Throttle Range Setting”.

Alert Tone

1. Input voltage is abnormal: The ESC begins to check the voltage when the battery pack is connected, if the voltage is not in the acceptable range, such an alert tone will be emitted: “beep-beep-, beep-beep-,beep-beep-” (Every “beep-beep-” has a time interval of about 1 second.)
2. Throttle signal is abnormal: When the ESC can’t detect the normal throttle signal, such an alert tone will be emitted: “beep-, beep-, beep-”. (Every “beep-” has a time interval of about 2 seconds)
3. Throttle stick is not in the bottom position: When the throttle stick is not in bottom (lowest) position, a very rapid alert tone will be emitted: “beep-, beep-, beep-”. (Every “beep-” has a time interval of about 0.25 second.)

Protection Function

1. Abnormal start up protection: If the motor fails to start within 2 seconds of throttle application, the ESC will cut-off the output power. In this case, the throttle stick **MUST** be moved to the bottom again to restart the motor. (Such a situation happens in the following cases: The connection between ESC and motor is not reliable, the propeller or the motor is blocked, the gearbox is damaged, etc.)
2. Over-heat protection: When the temperature of the ESC is over 110 Celsius degrees**,** the ESC will reduce the output power.
3. Throttle signal loss protection: The ESC will reduce the output power if throttle signal is lost for 1 second, further loss for 2 seconds will cause its output to be cut-off completely.

Program Example

Setting “Start Mode” to “Super-Soft”, i.e. value #3 in the programmable item #5

1. Enter Program Mode
Switch on transmitter, move throttle stick to top position, connect battery pack to ESC, wait for 2 seconds, “beep-beep” tone should be emitted. Then wait for another 5 seconds, special tone like ‘♪ 5671̇2̇” should be emitted, which means program mode is entered.

2. Select Programmable Items
Now you’ll hear 8 tones in a loop. When a long “beep------” tone is emitted, move throttle stick to bottom to enter the “Start Mode”

3. Set Item Value (Programmable Value)
“Beep-”, wait for 3 seconds; “Beep-beep-”, wait for another 3 seconds; then you’ll hear “beep-beep-beep”, move throttle stick to top position, then a special tone “ ♪1̇5̇1̇5̇” is emitted, now you have set the “Start Mode” item to the value of “Super-Soft”

4. Exit Program Mode
After the special tone “♪1̇5̇1̇5̇”, move throttle stick to bottom within 2 seconds.

Trouble Shooting

Trouble	Possible Reason	Action
After power on, motor does not work, no sound is emitted	The connection between battery pack and ESC is not correct	Check the power connection. Replace the connector.
After power on, motor does not work, such an alert tone is emitted: “beep-beep-, beep-beep-,beep-beep-” (Every “beep-beep-” has a time interval of about 1 second)	Input voltage is abnormal, too high or too low. The balance charge connector is not located properly in BDMP adapter.	Check the voltage of battery pack Check the connection of the balance charge connector and the BDMP adapter.
After power on, motor does not work, such an alert tone is emitted: “beep-, beep-, beep- ”(Every “beep-” has a time interval of about 2 seconds)	Throttle signal is irregular	Check the receiver and transmitter Check the cable of throttle channel
After power on, motor does not work, such an alert tone is emitted: “beep-, beep-, beep-” (Every “beep-” has a time interval of about 0.25 second)	The throttle stick is not in the bottom (lowest) position	Move the throttle stick to bottom position
After power on, motor does not work, a special tone “ ♪ 5671̇2̇” is emitted after 2 beep tone (beep-beep-)	Direction of the throttle channel is reversed, so the ESC has entered the program mode	Set the direction of throttle channel correctly
The motor runs in the opposite direction	The connection between ESC and the motor need to be changed.	Swap any two wire connections between ESC and motor
The motor stop running while in working state	Throttle signal is lost	Check the receiver and transmitter Check the cable of throttle channel
	ESC has entered Low Voltage Protection mode	Land RC model as soon as possible, and then replace the battery pack
	Some connections are not reliable	Check all the connections: battery pack connection, throttle signal cable, motor connections, etc.
Random stop or restart or irregular working state	There is strong electro-magnetic interference in flying field.	Reset the ESC to resume normal operation. If the function could not resume, you might need to move to another area to fly.

Normal startup procedure:

Move throttle stick to bottom and then switch on transmitter.	Connect battery pack to ESC, special tone like "♪123" means power supply is OK	Several "beep-" tones should be emitted, presenting the number of lithium battery cells	When self-test is finished, a long "beep-----"tone should be emitted	Move throttle stick upwards to go flying

Throttle range setting: (Throttle range should be reset whenever a new transmitter is being used)

Switch on transmitter, move throttle stick to top	Connect battery pack to ESC, and wait for about 2 seconds	"Beep-Beep-" tone should be emitted, means throttle range highest point has been correctly confirmed	Move throttle stick to the bottom, several "beep-" tones should be emitted, presenting the number of battery cells	A long "Beep-" tone should be emitted, means throttle range lowest point has been correctly confirmed

Program the ESC with your transmitter (4 Steps):

1. Enter program mode
2. Select programmable items
3. Set item's value (Programmable value)
4. Exit program mode

1. Enter program mode

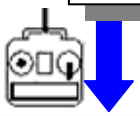
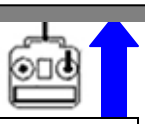
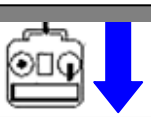
1) Switch on transmitter, move throttle stick to top , connect the battery pack to ESC
2) Wait for 2 seconds, the motor should emit special tone like "beep-beep-"
3) Wait for another 5 seconds, special tone like "♪567i2" should be emitted, which means program mode is entered

2. Select programmable items:

After entering program mode, you will hear 8 tones in a loop with the following sequence. If you move the throttle stick to bottom within 3 seconds after one kind of tones, this item will be selected.

1.	"beep"	brake	(1 short tone)
2.	"beep-beep-"	battery type	(2 short tone)
3.	"beep-beep-beep-"	cutoff mode	(3 short tone)
4.	"beep-beep-beep-beep-"	cutoff threshold	(4 short tone)
5.	"beep-----"	startup mode	(1 long tone)
6.	"beep-----beep-"	timing	(1 long 1 short)
7.	"beep-----beep-beep-"	set all to default	(1 long 2 short)
8.	"beep-----beep-----"	exit	(2 long tone)

Note: 1 long "beep-----" = 5 short "beep-"

3. Set item value (Programmable value):

You will hear several tones in loop. Set the value matching to a tone by moving throttle stick to top when you hear the tone, then a special tone "♪i5i5" emits, means the value is set and saved. (Keeping the throttle stick at top, you will go back to step 2 and you can select other items; Moving the stick to bottom within 2 seconds will exit program mode directly)

Tones / Items	"beep-" 1 short tone	"beep-beep-" 2 short tones	"beep-beep-beep" 3 short tones
Brake	**Off**	On	
Battery type	**Li-ion / Li-poly**	NiMH / NiCd	
Cutoff mode	**Soft-Cut**	Cut-Off	
Cutoff threshold	Low	**Medium**	High
Start mode	Normal	Soft	**Super soft**
Timing	**Low**	Medium	High

4. Exit program mode

There are 2 ways to exit program mode:

1. In step 3, after special tone "♪i5i5", please move throttle stick to the bottom position within 2 seconds.
2. In step 2, after tone "beep-----beep-----" (i.e. item #8), move throttle stick to bottom within 3 seconds.